

INDOOR AIR QUALITY ASSESSMENT

**Morris Elementary School
129 West Street
Lenox, Massachusetts**



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
June, 2002

Background/Introduction

At the request of school officials, an indoor air quality assessment was done at the Morris Elementary School, 129 West Street, Lenox, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA). Concerns about sewer gas and other indoor air quality concerns prompted this evaluation. On February 14, 2002, a visit was made to this school by Mike Feeney, Director of Emergency Response/Indoor Air Quality, BEHA, to conduct an assessment. Mr. Feeney was accompanied by Judy Dean of the American Lung Association of Western Massachusetts and Michael Steurwald of the Morris Elementary School.

The building consists of two wings. The original building was constructed in 1959 as a single story red brick structure. A two-story wing of fourteen classrooms was constructed in 1996 and is attached by a split-level staircase to the rear of the original building. A second addition to the front of the building added kindergarten classrooms, administrative offices, a library and workroom during the 1996 construction. Classrooms have openable windows. The building is covered by a peaked roof.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for hydrogen sulfide were taken with a BW Technologies, Model # D4-2000, Multigas detector.

Results

This elementary school has a student population of over 380 and a staff of approximately 80. Tests were taken during normal operations at the school and results appear in Tables 1-4.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million parts of air (ppm) in fifteen of thirty-eight areas tested. Carbon dioxide levels above the comfort guidelines set by the BEHA are indicative of a possible ventilation problem in some classrooms.

Fresh air in classrooms is supplied by a unit ventilator (univent) system (see Picture 1). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an air intake located at the base of each unit. The mixture of fresh and return air is drawn through a filter and a heating/cooling coil, and is then provided to classrooms from the univent by motorized fans through fresh air diffusers located at the top of the unit (see [Figure 1](#)). Univents were functioning in all but two classrooms examined. Univents were found blocked with chairs, desks, books and other obstructions (see Tables). In order for univents to function as designed, the fresh air diffuser and return vents must be clear of obstacles. Exhaust ventilation in classrooms is provided by a mechanical exhaust system. Exhaust vents were operating in all assessed classrooms.

In order to have proper ventilation with a univent and exhaust system, these systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of balancing of these systems was reportedly conducted in 1996. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The speech room, hallways and the principal's office do not have mechanical fresh air supply or exhaust vents. Fresh air is supplied by openable windows, except in the speech room, which has no openable windows.

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please consult [Appendix I](#).

Temperature measurements ranged from 68° F to 74° F, which were within or very close to the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building ranged from 15 to 24 percent, which was below the BEHA recommended comfort range in all areas. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Several rooms contained a number of plants, some of which were located near univents. Plants should have drip pans to prevent wetting and subsequent mold colonization of window frames. Plant soil and drip pans can also provide a source of mold growth. Over-watering of plants should be avoided and drip pans should be inspected periodically for mold growth. Plants should also be located away from univents and exhaust ventilation to prevent the aerosolization of mold, dirt and pollen. Several areas had planters on carpeting. Planters on carpets can result in chronic moistening of carpeting from over-watering or condensation on the underside of the drip pan or pot.

The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that carpeting be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If carpets are not dried within this time frame, mold growth may occur. Water-damaged carpeting cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy carpeting is not recommended.

Mr. Steurwald reported that a pipe within a walk-in refrigerator serves as a source of chronic water generation (see Picture 2). When warm, moist air passes over a surface that is colder than the air, water condensation can collect on the cold surface. Over time, water droplets can form, which can then drip from a suspended surface. For this reason, pipes in refrigerated spaces are insulated. The insulation on this pipe is incomplete. Insulation should be continuous over the entire course of the pipe, with all seams and ends sealed to prevent air contact with the pipe.

Other Concerns

The conditions within room 129 were examined to determine possible sources of pollutants that may be entering this area. Of note is the location of this room. It is the only room located on a cement slab that was installed during the 1996 renovation. The junction between the exterior wall and slab is unsealed (see Picture 3). A board exists within this seam, which may have been used when the slab was poured. A roof was installed over the slab. A downspout from the roof empties onto a tarmac building apron that appears to be sloped toward the slab. In addition the downspout elbow terminates on the slab, which may result in the placement of water on the slab (see Picture 4).

The depression in the tarmac at the slab junction can create puddling, which may then moisten the boards and allow for moisture to enter the exterior wall system. A long crack exists along the floor/exterior wall junction in room 129, which roughly corresponds to the areas of the slab. Installed beneath the window is a univent. The interior cabinet of this univent was examined. Spaces in the air handling cabinet (see Picture 5) of the univent would draw air that bypasses filters and in turn draw air from the spaces in the interior wall/floor junction.

If this area of the wall system is chronically wetted from water penetration through the slab/exterior wall crack, then the operation of the univent may draw pollutants (including microbial growth) from the wall system, which can in turn bypass the filter and become aerosolized. The univent installation, interior wall/floor crack, the exterior wall/slab crack, length of the gutter and pitch of the tarmac apron would all need to be addressed to correct this problem.

The area that experiences sewer odor was examined. This area includes the hallway that leads to the split-level stairway that connects the two-story addition to the original building (see Diagram 1). Mr. Steurwald indicated that the odor may originate

from a restroom adjacent to the hallway. Floor tile near an interior wall has become loose without any apparent water source from within the restroom, ceiling or wall systems. This lack of adhesion may indicate that the sewer pipe from this area may have a crack, which is resulting in water wicking up the cement slab to a place beneath the loose tile. It is believed that the sewer gas odor noted in this area is attributed to air backing up the system when properties in the area pump their sewerage into the system. It is reportedly planned for a backflow preventer to be installed in the sewer line exiting the building to eliminate this occurrence.

This planned installation does not establish whether the drainpipe in the building is cracked. The school department has attempted to establish whether a crack exists, including use of a camera system inserted into the pipe. During the course of this assessment, BEHA staff conducted hydrogen sulfide air monitoring. No measurable levels of hydrogen sulfide or sewer gas-like odors were detected. In order to ascertain whether the pipe is cracked, BEHA staff suggested that oil of spearmint be poured into the rooftop vent pipe that services the restrooms. This should be done after school hours. If spearmint odor is detected in the restroom, that would indicate the existence of a cracked pipe.

Several other conditions that can potentially affect indoor air quality were also identified. Shrubbery in direct contact with the exterior wall brick was noted in several areas around the building (see Picture 6). Shrubbery can serve as a possible source of water impingement on the exterior curtain wall due to the location of plants and tree branches growing directly against the building. Plants retain water and in some cases can work their way into mortar and brickwork causing cracks and fissures, which may subsequently lead to water penetration and possible mold growth. One classroom also

has a garden located outside, near the fresh air intake of the classroom univent (see Picture 7). Plants can be a source of materials that are irritating to the respiratory system.

As previously discussed, the interiors of univents in the original building were spot-checked. Walls in which univents are installed have spaces and holes within the casing that open into the wall cavity. Also noted, were spaces around heating pipes that penetrate through the floor. Spaces of this nature can result in the univent drawing air and debris from the wall cavity and distributing these materials to the interior of the building.

Also of note was the amount of materials stored inside some classrooms. In classrooms throughout the school, items were seen piled on windowsills, tabletops, counters, bookcases and desks. The large amount of items stored in classrooms provides a means for dusts, dirt and other potential respiratory irritants to accumulate. Many of the items, (e.g., papers, folders, boxes, etc.) are tough to clean and make it difficult for custodial staff to clean around these areas. Dust can be irritating to the eyes, nose and respiratory tract. These items should be relocated and/or cleaned periodically to avoid excessive dust build up.

A significant accumulation of stored soft drink cans was noted in some classrooms. Food and their containers may have residue that can serve to attract pests (e.g., mice and cockroaches). The use of these materials in art projects should be avoided to prevent the necessity for use of pesticides to rid the building of infestations.

In an effort to reduce noise from sliding chairs, tennis balls are sliced open and placed on chair legs (see Picture 8) in some areas. Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and off-gas volatile organic compounds (VOCs). Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad.

Use of tennis balls in this manner may introduce latex dust into the school environment. In addition, examination disposable gloves containing latex was observed within the building. The use of latex gloves may also introduce allergenic powder into the environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix II (NIOSH, 1998).

Of note is the use of different VOC containing products in the building. Rubber cement may contain n-hexane, which can be irritating to the eyes, nose and throat; in addition n-hexane is an extremely flammable material. Local exhaust ventilation should be utilized when this material is used. Six containers of rubber cement were found stored in a cabinet within room 124 (see Picture 9). Due to the quantity and flammable nature of rubber cement, these materials should be stored in a flameproof cabinet that meets the standards of the National Fire Prevention Association (NFPA) (NFPA, 1996).

Permanent markers also may contain VOCs, which, as stated, can be irritating to the eyes, nose and throat. Under the Labeling of Hazardous Art Materials Act (LHAMA), art supplies containing hazardous materials that can cause chronic health effects must be labeled as required by federal law (USC, 1988). The use of art supplies containing hazardous materials that can cause chronic health effects should be limited to times when students are not present and only when adequate exhaust ventilation is available.

Paper and plastic items were found stored within the kiln room. Heating of these materials may increase the release of chemicals from paper and plastic and are also a fire

hazard. In general, non-flammable materials are the only materials that should exist in a kiln room due to the high operating temperature of this equipment.

Room 125 has a photocopier that is installed in front of the return vent of the univent. In this configuration, the univent may draw waste heat, ozone and VOCs and enhance the distribution of these materials into the room. A lamination machine also exists in the room. Lamination machines may also be source of waste heat and odors. Photocopiers and laminators may produce odors and other materials that can be irritating to the eyes, nose and throat.

Complaints of bus exhaust odors have been reported within the building. This has been attributed to the idling of busses at the student drop-off area (see Picture 10) and the entrainment of vehicle exhaust into the building via the ventilation system. M.G.L. chapter 90 section 16A prohibits the unnecessary operation of the engine of a motor vehicle for a foreseeable time in excess of five minutes (MGL, 1986).

A bucket labeled “corrosive” was noted in room 129, which was used for waste paper (see Picture 11). Containers used to store hazardous materials should not be recycled in this manner, since the container may continue to have a residue of the materials originally stored in the container.

Conclusions/Recommendations

There appear to be several conditions affecting indoor air quality involving the school's various ventilation systems and several means for particulates such as mold being entrained by the HVAC system and distributed through the building that require attention. For these reasons a two-phase approach is required, consisting of immediate **short-term** measures to improve air quality and **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns within the building.

In view of the findings at the time of the inspection, the following **short-term** recommendations are made:

1. Continue with plans to install a backflow preventer on the sewer line.
2. In order to address the condition denoted in room 129:
 - a) Remove the board from the slab/exterior wall junction and seal the seam with an appropriate caulking compound
 - b) Seal the interior wall/floor seal with an appropriate sealant
 - c) Alter the pitch of the tarmac apron for water to drain away from the slab and building;
 - d) Add an extension to the downspout to have rainwater drain onto the tarmac apron instead of the slab.
3. Examine each AHU and univent for proper function. Survey equipment to ascertain if an adequate air supply exists for each area serviced. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the maintenance and calibration of HVAC equipment and univent fresh air control dampers school-wide.

4. Seal holes inside univents with rigid foil faced sheet material and water based high temperature and fiber reinforced mastic. Temporarily sealing the holes in this manner would prevent both air and moisture penetration into univents.
5. Remove potentially flammable materials from kiln room.
6. Remove all blockages from univents and exhaust vents to ensure adequate airflow.
7. Once both the fresh air supply and the exhaust ventilation are functioning properly, the system should be balanced by an HVAC engineer.
8. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all non-porous surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
9. Store food products in airtight containers and cans in sealed plastic bags to prevent the attraction of pests.
10. Discontinue the use of tennis balls on chairs to prevent latex dust generation.
Consider using an alternative to latex gloves.
11. Remove plants over or in close proximity to univent fresh air diffusers.
12. Reduce/trim or remove plants that are growing against the exterior brick curtain wall.
13. Consider moving gardens away from fresh air intakes.
14. Move the photocopier away from the univent in room 125.

15. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
16. Store flammable materials in flameproof cabinets consistent with local and state fire codes.
17. In order to ascertain whether the pipe is cracked, BEHA staff suggested that oil of spearmint be poured into the rooftop vent pipe that services the restrooms. This should be done after school hours. If spearmint odor is detected in the restroom, that would indicate the existence of a cracked pipe.
18. Acquire current Material Safety Data Sheets for all products that are used in the building that contain hazardous materials (e.g., rubber cement), including office supplies, in conformance with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL, 1983).
19. Totally insulate the pipe in the refrigerator with insulation with a sufficient R-rating to prevent condensation.
20. Relocate student drop off area or have busses shut off engines after five minutes as required by Massachusetts General Laws 90:16A.

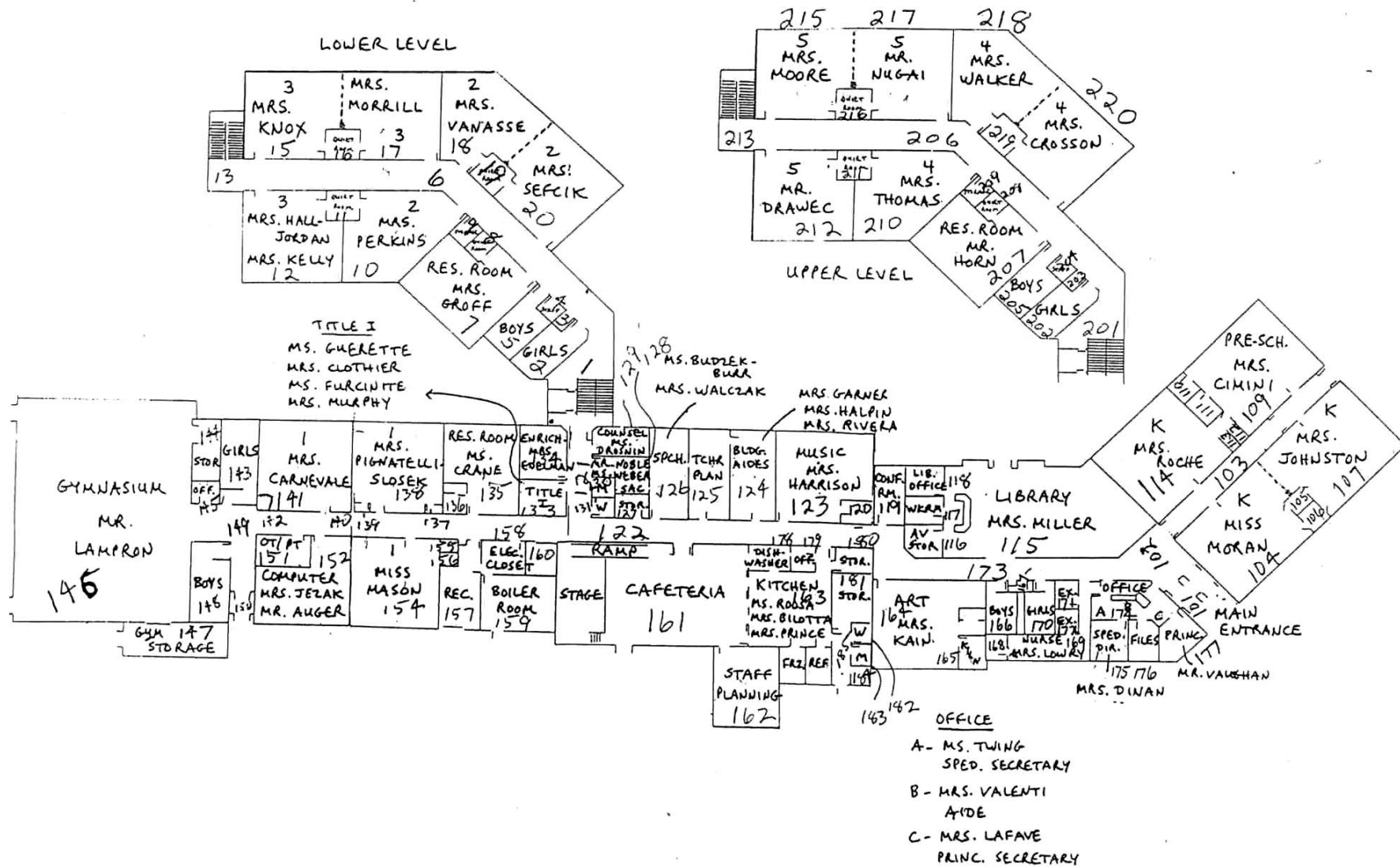
Long-term Recommendations

1. If sewer odor persists after the installation of the backflow preventer, excavating the pipe from the floor for replacement may be the most efficacious remediation method. Consider consulting a plumbing contractor for alternative feasible methods that may be used to reseal pipe short of excavation.

References

- ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.
- BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL.
- MGL. 1983. Hazardous Substances Disclosure by Employers. Massachusetts General Laws. M.G.L. c. 111F.
- MGL. 1996. Stopped motor vehicles; Operation of Engine; Time Limit; Penalty. Massachusetts General Laws. M.G.L. c. 90:16A.
- NFPA. 1996. Flammable and Combustible Liquids Code. 1996 ed. National Fire Protection Association, Quincy, MA. NFPA 30.
- NIOSH. 1998. Latex Allergy A Prevention. National Institute for Occupational Safety and Health, Atlanta, GA.
- NIOSH. 1997. NIOSH Alert Preventing Allergic Reactions to Natural Rubber latex in the Workplace. National Institute for Occupational Safety and Health, Atlanta, GA.
- OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.
- SBAA. 2001. Latex In the Home And Community Updated Spring 2001. Spina Bifida Association of America, Washington, DC.
[Http://www.sbaa.org/html/sbaa_mlatex.html](http://www.sbaa.org/html/sbaa_mlatex.html)
- SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0
- SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.
- USC. 1988. Labeling of Hazardous Art Materials Act (LHAMA). U.S. Code. 15 U.S.C. 1277(b)(1).

Diagram 1
Layout of Morris Elementary School, Lenox, MA



Picture 1



Univent in Classroom, Note Blockage with Materials

Picture 2



Pipe Within Walk-In Refrigerator

Picture 3



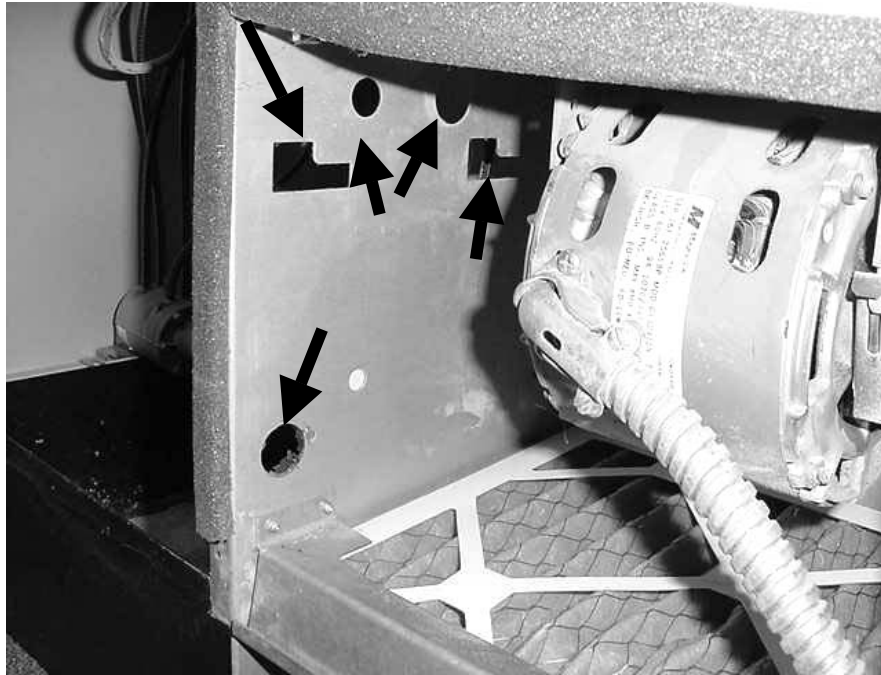
Slab/Exterior Wall Junction, Note Board

Picture 4



Downspout That Terminates on the Slab, Note the Dirt Accumulation and Wet Spot on the Tarmac, Which May Denote Water Puddling

Picture 5



Spaces In The Air Handling Cabinet Wall

Picture 6



Shrubbery In Contact With Exterior Wall

Picture 7



Garden In Close Proximity to Univent Fresh Air Intake

Picture 8



Tennis Balls On Stool Legs

Picture 9



Rubber Cement Containers Extracted From Storage Cabinet in Background

Picture 10



Busses In Close Proximity to Front of the Building

Picture 11



Recycled Container Labeled as Corrosive

TABLE 1

Indoor Air Test Results – Morris Elementary School, Lenox, MA – February 14, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|-------------------------|------------------------|-------------|------------------------|----------------------|---------------------|-------------|---------|--|
| | | | | | | Intake | Exhaust | |
| Outside (Background) | 347 | 34 | 27 | | | | | |
| Room 109 | 554 | 71 | 17 | 1 | Yes | Yes | Yes | Univent return blocked by desk, plants, water damage |
| Room 107 | 836 | 72 | 21 | 17 | Yes | Yes | Yes | Cleaning product |
| Room 104 | 673 | 72 | 18 | 1 | Yes | Yes | Yes | Univent return blocked by desk, spray-cleaner on shelf |
| Room 114 | 880 | 72 | 19 | 19 | Yes | Yes | Yes | Spray-cleaner |
| Administration Office | 726 | 73 | 20 | 4 | Yes | Yes | Yes | |
| Nurse's Office | 672 | 73 | 18 | 1 | Yes | Yes | Yes | Latex gloves |
| Library | 513 | 73 | 15 | 7 | Yes | Yes | Yes | Plants |
| 116 – AV Storage | | | | | | | | Mold odor-library materials |
| Art Room | 554 | 69 | 17 | 0 | Yes | Yes | Yes | Univent blocked by art, tennis balls, paper/plastic in kiln room |
| Music Room | 792 | 68 | 20 | 0 | Yes | Yes | Yes | |

* ppm = parts per million parts of air
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 2

Indoor Air Test Results – Morris Elementary School, Lenox, MA – February 14, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---------------|------------------------|-------------|------------------------|----------------------|---------------------|-------------|---------|--|
| | | | | | | Intake | Exhaust | |
| Room 124 | 559 | 70 | 18 | 2 | Yes | Yes | Yes | Lamination machine, rubber cement, paper |
| Room 125 | 690 | 71 | 17 | 1 | Yes | Yes | Yes | Lamination machine, photocopier, door open |
| Cafeteria | 686 | 72 | 18 | 50+ | Yes | Yes | Yes | |
| Speech Room | 792 | 72 | 18 | 7 | Yes | Yes | Yes | |
| Room 129 | 1098 | 74 | 21 | 4 | Yes | Yes | Yes | Univent off, recycled “corrosive” container |
| Room 135 | 499 | 72 | 15 | 2 | Yes | Yes | Yes | Food, plants, door open |
| Room 154 | 906 | 71 | 19 | 4 | Yes | Yes | Yes | Plants, accumulated items, door open |
| Room 138 | 749 | 71 | 18 | 2 | Yes | Yes | Yes | Door open |
| Computer Room | 640 | 71 | 17 | 10 | Yes | Yes | Yes | 19 computers |
| Room 141 | 635 | 70 | 18 | 1 | Yes | Yes | Yes | Univent blocked by chair/plants/accumulated items, door open |

* ppm = parts per million parts of air
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
 600 - 800 ppm = acceptable
 > 800 ppm = indicative of ventilation problems
 Temperature - 70 - 78 °F
 Relative Humidity - 40 - 60%

TABLE 3

Indoor Air Test Results – Morris Elementary School, Lenox, MA – February 14, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|-----------|------------------------|-------------|------------------------|----------------------|---------------------|-------------|---------|---|
| | | | | | | Intake | Exhaust | |
| Gymnasium | 493 | 71 | 17 | 20+ | Yes | Yes | Yes | |
| Room 133 | 604 | 70 | 17 | 1 | No | Yes | Yes | |
| Room 134 | 596 | 72 | 17 | 3 | Yes | Yes | Yes | |
| Room 128 | 499 | 74 | 16 | 0 | No | Yes | Yes | Scented candle |
| Room 207 | 1316 | 73 | 23 | 21 | Yes | Yes | Yes | Plants |
| Room 210 | 998 | 73 | 20 | 19 | Yes | Yes | Yes | Univent blocked by chairs |
| Room 212 | 583 | 72 | 17 | 21 | Yes | Yes | Yes | Univent blocked by desk, soda cans, accumulated items |
| Room 215 | 822 | 71 | 19 | 19 | Yes | Yes | Yes | |
| Room 217 | 829 | 71 | 20 | 19 | Yes | Yes | Yes | Books on univent, plants, food |
| Room 218 | 1983 | 72 | 24 | 14 | Yes | Yes | Yes | Plant on carpet |
| Room 220 | 1529 | 71 | 22 | 22 | Yes | Yes | Yes | Accumulated items |

* ppm = parts per million parts of air
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
 600 - 800 ppm = acceptable
 > 800 ppm = indicative of ventilation problems
 Temperature - 70 - 78 °F
 Relative Humidity - 40 - 60%

TABLE 4

Indoor Air Test Results – Morris Elementary School, Lenox, MA – February 14, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|----------|------------------------|-------------|------------------------|----------------------|---------------------|-------------|---------|---|
| | | | | | | Intake | Exhaust | |
| Room 007 | 604 | 70 | 18 | 1 | Yes | Yes | Yes | Univent return blocked by desk, door open |
| Room 010 | 1122 | 70 | 20 | 17 | Yes | Yes | Yes | Plant on univent, door open |
| Room 012 | 1277 | 71 | 22 | 16 | Yes | Yes | Yes | Plants on univent and carpet |
| Room 015 | 948 | 69 | 19 | 1 | Yes | Yes | Yes | Univent off, door open |
| Room 017 | 618 | 67 | 17 | 1 | Yes | Yes | Yes | Window and door open |
| Room 018 | 934 | 69 | 20 | 19 | Yes | Yes | Yes | Soda cans |
| Room 019 | 1363 | 70 | 22 | 19 | Yes | Yes | Yes | Permanent marker |

Comfort Guidelines

* ppm = parts per million parts of air
CT = ceiling tiles

Carbon Dioxide - < 600 ppm = preferred
 600 - 800 ppm = acceptable
 > 800 ppm = indicative of ventilation problems
 Temperature - 70 - 78 °F
 Relative Humidity - 40 - 60%